Modelling of the performance of timber structures

COST Action E55

Presentation of the Memorandum of Understanding

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Outline

• Motivation
• Objectives
• Scientific Program
• Realization
• Participation
• Communication
The Life-Cycle of Timber Structures
The Life-Cycle of Timber Structures

Motivation
Objectives
Scientific Program
Realization
Participation
Communication

Decisions under Uncertainty

Uncertainties related to e.g.
- Traffic volume
- Loads
- Resistances (material, soil,..)
- Degradation processes
- Service life
- Manufacturing costs
- Execution costs
- Decommissioning costs
The Life-Cycle of Timber Structures

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The Performance of Timber Structures

Derived from 'End-User Requirements':

- Reliability
- Serviceability
- Durability
- Good Value for Money
- Good Appearance
The Performance of Timber Structures

Structural Engineering Decision Problem:

Design Process:

- Risk Screening (Assessment of Failures and Malfunctions)
- Identification of Design Situations
- Detailed Quantification of Design Strategies
### The Performance of Timber Structures

**Structural Engineering Decision Problem:**

**Design Process:**
- Risk Screening (Assessment of Failures and Malfunctions)
- Identification of Design Situations
- Detailed Quantification of Design Strategies

**Efficient in terms of the Performance (e.g. Expected cost)**
The Performance of Timber Structures

Structural Engineering Decision Problem:

Optimal Design:

Expected Benefit of the Structure

Benefit of the Structure in Service

Reliability

Risk

\[ E[B] = I \left(1 - P_F(C_D)\right) - C_D - C_F P_F(C_D) \Rightarrow \frac{\partial E[B]}{\partial C_D} = 0 \]
The Performance of Timber Structures

Structural Engineering Decision Problem:

Optimal Design:

Expected Benefit of the Structure

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Benefit of the Structure in Service

Reliability

Risk

Probability of Failure:

\[ P_f = P\left(R - S \leq 0\right) \]

\[ P_f = P\left(g(X) \leq 0\right) = \int_{g(x)\leq0} f_X(x) \, dx \]
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Codes and regulations:
- Deterministic limit state equations
- Loads, resistance, safety factors

--> Decision support tool for engineers

Derived by code authorities

Traditionally based on experience and judgement
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Motivation

Objectives

Scientific Program

Realization

Participation

Communication

Basis of Design:

- Toolbox for the formal treatment of uncertainties in design
- Probabilistic models for loads and resistances
- Reliability methods, decision theory

--> Decision support tool for code authorities

--> JCSS Probabilistic Model Code

+ Research findings (e.g. CIB W18)
The Performance of Timber Structures

Motivation          Objectives          Scientific Program          Realization          Participation          Communication

Risk Screening
(Assessment of Failures and Malfunctions)

Identification of Design and Assessment Situations

Component aspects

System aspects

Exposures (Loads and Environment)

Model Building & Verification

Evidence from Experiments

Physical Hypothesis

Quantified Models & Uncertainty

Basis of Design

Codes

Detailed Quantification of Design and Assessment Strategies
The Performance of Timber Structures

- Based on the most relevant and exact information available
- Consistent level of sophistication
What are the goals?

- Identify what is really essential to research further
- Verify models for component and system performance for timber structures
- Extend the focus to the operation and maintenance phase of the structures’ lifecycle
What are specific objectives?

- **Assessment of failures and malfunctions**

Diagram:

1. Risk Screening (Assessment of Failures and Malfunctions)
2. Identification of Design and Assessment Situations
   - Basis of Design
   - Codes
3. Detailed Quantification of Design and Assessment Strategies
4. Component aspects
5. System aspects
6. Exposures (Loads and Environment)
7. Model Building & Verification
   - Evidence from Experiments
   - Physical Hypothesis
8. Quantified Models & Uncertainty
What are specific objectives?

- **Identification of relevant exposures and their representation**
What are specific objectives?

- Improvement of the basic understanding of structural components and connections

Modeling the Performance of Timber Structures

December 15, 2006
What are specific objectives?

- Improvement of the basic understanding of wood degradation processes
What are specific objectives?

- Assessment of robustness and system aspects for timber structures
What are specific objectives?

- Development of risk management and control methods
The Benefit

- Improving design methods, assessment techniques and maintenance policies
  - Tools which make engineers and planners more confident working with timber
  - Structures which provide expected high performance
Scientific Program

- Three main areas: 
  - Assessment of failures → WG1
  - Vulnerability of components → WG2
  - Robustness of systems → WG3

Three main areas:

Motivation | Objectives | Scientific Program | Realization | Participation | Communication
WG1 - Assessment of failures

• Collecting information about failed and malfunctioning timber structures and components

• Analysis of the failure and malfunctioning mechanism

• Identification of relevant design and assessment situations
**WG2 - Vulnerability of components**

- Basic strength and stiffness properties of graded timber material and engineered timber products

- Dependency of these properties on load and climate scenarios, size dependencies

- Strength and stiffness properties of connections

- Modeling of the durability of timber components and connections
### WG3 - Robustness of systems

- Characterization of multi-scale variability in timber structures
- Analysis of system effects for several types of timber structures
- Qualification of robustness as a characteristic of timber structures
- Establishing a framework for reliability based design and assessment of timber structural systems based on these considerations
Time Perspective / Milestones

Kick off
-set up WG/MC
-coordination
-industry

STSMs /Summer Schools
MC/WG meetings – 2 Conferences

Failure assessment
Vulnerability
Robustness

48 Month

Homepage  DReport G  FReport G
DReport FA  FReport FA
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Time Perspective / Milestones

<table>
<thead>
<tr>
<th>Frame</th>
<th>MC Meetings</th>
<th>WG Meetings</th>
<th>Conferences</th>
<th>STSM</th>
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- Homepage Entry into force: 12/10/2006
- SR_Failure Analysis SR_Failure Analysis SR_Failure Analysis
- DrSR_General
- SR_General End of Action: 14/12/2010

CSO approval date: 27/06/2006

SR: Scientific Report
DrSR: Draft Scientific Report

December 15, 2006
Related National Projects

E.g.*

- **Sweden/Finland**: Assessment of Failures
- **France**: Glued Laminated Timber, Repair, System effects
- **Switzerland**: Glued Laminated Timber, Reliability, Grading
- **The Netherlands**: Connections, Grading
- **Denmark**: Moisture/Time – Strength/Stiffness
- **Sweden**: Moisture/Time – Strength/Stiffness
- **Germany**: Size effects, Assessment of Failures
- ...

*(Information obtained during approval phase, needs to be updated)*
Link to research communities and code authorities

Working Group for Timber Structures of the international Council for Research and Innovation in Building and Construction

- RILEM
- International Association for Building Materials and Structures

COST E55

- CIB W18
- Joint Committee on Structural Safety

ISO Technical Committee for timber structures

- ISO TC 165
- CEN
- The European Committee for Standardization

Modeling the Performance of Timber Structures

December 15, 2006
Motivation | Objectives | Scientific Program | **Realization** | Participation | Communication
---|---|---|---|---|---

**Link to other COST Actions**

- Quality Control of Wood and Wood Products
- COST E53
- COST TU601
- COST E55
- Robustness of Structures
- COST E29
- Innovative Timber & Composite Elements/Components for Buildings

Modeling the Performance of Timber Structures

December 15, 2006
Researchers from:

(14/12/06)

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Intentions to sign

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indicated their interest for participation
Dissemination

- Promoting interdisciplinary, international research
- Participate in conferences organized by other relevant associations
- Publishing of co-authored papers
- Publishing information on the WWW
- Scientific Reports
Summary of the MoU

- The main objective of the Action is to provide the basic framework and knowledge required for the efficient and sustainable use of timber as a structural and building material.

- The scientific content will be developed by 3 working groups:
  - WG1: Assessment of Failures;
  - WG2: Vulnerability of Components
  - WG3: Robustness of Systems

- A lively interaction to other research communities and code authorities is crucial and will be actively developed / maintained.
Distribution of Tasks

- Working Group Leaders
- MC Reporting
- Grant Holder
- Homepage Responsible

- Core Group
- Coordinator – Research Associations / Code Authorities
- ...

Modeling the Performance of Timber Structures
# Intermediate-Term Planning

**Tentative Proposal (Progressive):**

<table>
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<td>January 07</td>
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The Core Group Meeting

Tentative Proposal:

- Organization of the Workshop
- Set up of a WS Program
- Creation Folder
- Review Homepage draft

- Where and when?
The Workshop

Tentative Proposal:

- 40 – 50 Participants approx. 3 per Country, evtl. Guest speakers.
- 2 Full Days.
- Country wise brief presentations of the participating institutions (background, potential and expectations).
- 4 lectures – General, Assessment of Failures, Components, Robustness.
- Plenum discussions.
- Presentation of (a) case study(ies).
- MC meeting.
Long-Term Planning

Tentative Proposal (Progressive):

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Thank you for your attention